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SIXTY-SEVENTH SESSION.

Monday, 5th February 1849.

Sir T. MAKDOUGALL BRISBANE, Bart., President,
in the Chair.

The following Donations to the Library were announced:—

Abhandlungen der Mathematisch-Physikalischen Classe der K.
Bayerischen Akademie der Wissenschaften. Bde. I., II., III.,
& IV., Abtheil. 1 & 2. 4to.

Abhandlungen der Philosophisch-Philologischen Classe der K.
Bayerischen Akademie der Wissenschaften. Bde. I., II., III.,
& IV., Abtheil. 1 & 2. Bd. V., Abtheil. 1. 4to.

Die Chemie in ihrem verhältnisse zur Physiologie und Pathologie.
Von D. Max. Pettenkofer. 4to.

Denkrede auf Joseph Gerhard Zaccarini. Von Carl F. P. v. Martins.
4to.

Rede bei eröffnng der Sizung der K. Bayerischen Akademie der
Wissenschaften am 28 Marz 1848. Von Carl F. P. v. Martins.
4to.—*By the Academy.*

Bulletin de la Société de Géographie. Tom. IX., 3^{me} Série. 8vo.
—*By the Society.*

Journal of the London Geographical Society. Vol. XVIII., Part 2.
8vo.—*By the Society.*

Transactions of the China Branch of the Royal Asiatic Society. 1847.
8vo.—*By the Society.*

The American Journal of Science and Arts. 2d Series. Vol. VI.,
No. 18. 8vo.—*By the Editors.*

The Quarterly Journal of the Geological Society. No. 16. 8vo.
—*By the Society.*

VOL. II.



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Memoirs of the American Academy of Arts and Sciences. N.S.
Vol. III. 4to.—*By the Academy.*

The Ethnological Journal. No. 8. 8vo.—*By the Editor.*

Remarks on the Improvement of Tidal Rivers, illustrated by reference to works executed on the Tay and other rivers. By David Stevenson, F.R.S.E. 8vo.—*By the Author.*

Annales des Sciences Physiques et Naturelles, d'Agriculture et d'Industrie, publiées par la Société Royale d'Agriculture, &c., de Lyon. Tom. X. 8vo.—*By the Society.*

Annales de la Société Linnéenne de Lyon. Années 1845–6. 8vo.—*By the Society.*

Proceedings of the Royal Astronomical Society. Vol. IX., No. 2. 8vo.—*By the Society.*

Monday, February 19, 1849.

Mr CADELL in the Chair.

The following Communications were read :—

1. Abstract of a Communication on Rolling Curves.

This paper commenced with an outline of the nature and history of the problem of rolling curves, and it was shewn that the subject had been discussed previously, by several geometers, amongst whom were De la Hire and Nicolè in the *Mémoires de l'Académie*, Euler, Professor Willis, in his *Principles of Mechanism*, and the Rev. H. Holditch in the *Cambridge Philosophical Transactions*.

None of these authors, however, except the two last, had made any application of their methods ; and the principal object of the present communication was to find how far the general equations could be simplified in particular cases, and to apply the results to practice.

Several problems were then worked out, of which some were applicable to the generation of curves, and some to wheelwork ; while others were interesting as shewing the relations which exist between different curves ; and, finally, a collection of examples was added, as an illustration of the fertility of the methods employed.

2. On the Extraction of Mannite from the Dandelion. By Messrs Smith; with an Analysis of the Mannite, by Dr Stenhouse. Communicated by Dr George Wilson.

Messrs Smith stated that they had extracted from the dandelion, a large amount of a crystalline sweet substance, having all the physical characters of mannite. It was analysed by Dr Stenhouse, and found to contain carbon, hydrogen, and oxygen, in the proportions which characterise the accepted formula for mannite; viz., $C_6H_7O_6$, so that it certainly was the substance it was supposed to be.

Messrs Widmann and Frickhinger, it was stated, had anticipated Messrs Smith in the separation of mannite from the dandelion juice, and were led to believe that the mannite did not pre-exist ready formed in the dandelion; but was formed in the juice as the result of a peculiar fermentation which it underwent. This result was confirmed by the Messrs Smith, who experimented with large parcels of the plant, and found that even from quantities of the fresh root, so large as 40 lb., no mannite could be extracted, if the expressed juice were prevented from fermenting; whilst, if fermentation were permitted, the same weight of roots yielded a large quantity of mannite, which appears to be derived from the sugar, inulin, &c., of the dandelion, which were converted into mannite, gum, and lactic acid.

The Messrs Smith stated, in conclusion, that they had not been able to confirm the statement of Poley, that the dandelion contains a bitter crystallizable substance, such as he had described under the name of Taraxacine.

3. On some new Voltaic arrangements with Chlorous and Chromic Acids, with an account of a Battery, yielding electricity of great intensity, in which the negative, as well as the positive element is Zinc. By Dr Thomas Wright. Communicated by Dr G. Wilson.

The author, after referring to the principle on which the intense batteries of Daniel and Grove are constructed, and to the disadvantages connected with the use of the porous cells in those arrangements, stated that he had some time ago instituted a series of experiments, with a view to the construction of a voltaic circle of high electro-motive force, capable of being excited by a single solution, similarly to the battery of Mr Smee. Having employed a great

variety of solutions, he was led to consider mixtures of chromic or chlorous acid with dilute sulphuric acid, best adapted to the purpose he had proposed.

The chromic acid battery was arranged by twisting round one end of a cylinder of coke a copper conducting wire, soaking the part in boiling wax, and afterwards covering it with varnish, to protect the wire from the acid: the coke was then surrounded by a cylinder of amalgamated zinc, and firmly fixed in its place by wedges of varnished cork. To form the exciting liquid, a measure of strong sulphuric acid was added to an equal measure of a hot saturated solution of bichromate of potash: the mixture was then diluted with four measures of water, and set aside to cool. The coke and zinc cylinders placed in a tumbler of the solution possessed a high degree of electro-motive force, a single alternation being capable of decomposing acidulated water with platinum electrodes. The author stated, that the arrangement was not constant, its action gradually declining after immersion. But he considered that a small pair was well adapted for the excitation of electro-magnetic apparatus, from its possessing about three times the intensity of Smee's arrangement. In an experiment made by him with Dr Wilson, a series of four pairs, roughly put together in half-pint tumblers, decomposed acidulated water, at the rate of two cubic inches of mixed gases per minute with a cold, and four with a hot, charge of the chromic acid solution. No gas was evolved from the amalgamated zinc surface in either case. One of the advantages of the battery was, that a series of cylinders, however extensive, might, as in Wollaston's arrangement, be immersed and removed from the solution at once, and the energetic effects of first immersion obtained at pleasure. Platina, or boxwood charcoal might be used in place of coke: a small series of thirteen pairs (charcoal and amalgamated zinc), each exposing a surface of about a quarter of an inch square, afforded a shock equal to a Cruickshank's battery of fifty pairs of four-inch plates, a perceptible shock being even felt from four pairs.

The solution of chlorous or hypochloric acid (Cl O_4) was prepared, by pouring a drachm of powdered chlorate of potash into a wine glass containing an ounce of concentrated sulphuric acid, and in ten minutes afterwards plunging the mixture into seven ounces of water. A pair of plates (amalgamated zinc and thin sheet-brass) excited by the last solution gave a powerful current, until the chlorous acid was exhausted. The author had, however, more than once failed to ob-

tain any current from such an arrangement. A mixture of chlorate of potash and concentrated sulphuric acid formed a good charge for the negative side of Grove's double cell.

The author then proceeded to describe the platinized zinc battery. He was led to its discovery by observing that zinc (not amalgamated) has a tendency to assume an inactive state in some solutions containing a large quantity of sulphuric acid. Two or three arrangements were described, in which the negative plate consisted of zinc in various fluids, viz., dilute sulphuric acid, hypochloric acid and sulphuric acid, solution of sulphate of copper and sulphuric acid, &c. The most powerful battery of this class was formed by a negative plate of zinc included in a porous cell, containing a mixture of one measure of nitric acid with four of sulphuric acid, and associated with a double plate of zinc in a solution of potash or common salt. Such a circle was found to have an intensity equal to the battery of Professor Daniel, but by simply brushing the negative plate with a very dilute hot or acid solution of chloride of platinum, *the electro-motive force of the battery was doubled*, a single cell being then capable of decomposing water with platinum electrodes. A platinized zinc battery of three cells was placed on the table, the arrangement of the porous and outer cell being that of Professor Grove. The positive plate of each outer cell was folded over into the porous cell, and formed the negative plate of the pair next in series; there was therefore no necessity for binding screws, solderings, or mercury cups in the whole arrangement. The platinized zinc of each cell exposed a surface of 2.5 in. by 3.7 in. The series of three cells gave a cubic inch of mixed gases in 37 seconds, but the author considered that the battery would give two cubic inches of gas per minute, when the charge of the arrangement had become warm by the passage of the current. After use, the zinc plates were well rinsed in clean water and allowed to dry, and it was considered advisable to give them a slight brushing with the solution of platinum before their being again used. The platinized zinc battery was a *constant* arrangement.

The following Donations to the Library were announced:—

American Journal of Science and Arts. Conducted by Professors Silliman and Dana. Second series. Vol. VII., No. 19. 8vo.—
By the Editors.

Proceedings of the Academy of Natural Sciences of Philadelphia.

Vol. IV., Nos. 3, 4, 5. 8vo.—*By the Academy.*

Journal of the Statistical Society of London. Vol. XII., Part I.

8vo. *By the Society.*

Quarterly Journal of the Geological Society. No. 17. 8vo.—

By the Society.

The Ethnological Journal. No. 9. 8vo.—*By the Editor.*

Journal of the Indian Archipelago and Eastern Asia. Vol. II.,

Nos. 9, 10, 11, 12. 8vo.—*By the Editor.*

A Monograph of the British Naked-eyed Medusæ, with figures of all the species. By Edward Forbes, F.R.S. 4to.—*By the Author.*

Monday, March 5, 1849.

The Very Rev. Principal LEE, V.P., in the Chair.

The following communication was read :—

Biographical Notice of Dr Chalmers. By the Very Rev. E. B. Ramsay.

The writer of this paper commenced by stating his purpose of viewing Dr Chalmers as a public character only, and to avoid all questions which belonged to the peculiar relations in which he stood to his own religious communion ; and after a brief outline of the various circumstances of his life, and the dates belonging to each, the paper proposed to consider Dr Chalmers,—

- I. As an Author.
- II. As a Political Economist.
- III. As a Speaker.

I. Under the first head were noted the peculiarities of Dr Chalmers's mode of treating a subject, and the distinguishing points of his style, the abundance of his *imaginative* faculty, and the effects which were produced by it upon his writings.

II. Under the head of political economy, the principal object was to exhibit Dr Chalmers as a true Christian philanthropist. The circumstances connected with his management of the poor in St John's parish, Glasgow, were detailed ; and the influence which that experi-

ment had upon his views of pauperism and poor-laws, generally. Some objections to his Glasgow scheme were considered, and some misapprehensions of it were explained. Under this head were detailed his views on Ecclesiastical and Academical Endowments, and his testimony to the value of the English Church and Universities.

III. In considering Dr Chalmers as a public speaker, some specimens of his sermons were read, with remarks upon his eloquence in the pulpit. The case of his speech on the Catholic Emancipation Bill, was cited as an instance of great effect produced by eloquence at a public meeting. His striking reply to an accusation of inconsistency brought against him in the General Assembly, and a specimen of his mode of lecturing were given. Some observations were then made on his love of natural scenery, and his admiration of the beauties of the material world. His private character and social intercourse were referred to—his powers of conversation, and his perfect freedom from affectation, bigotry, or intolerance; of these qualities examples were cited, as also of his turn for humour, and his keen sense of the ridiculous. The author of the paper then concluded by stating his conviction, that although there might be differences of judgment regarding particular portions of Dr Chalmers's public acts and opinions, yet that no one who had known him personally, and who had been well acquainted with his real character—that no one who had studied and appreciated the spirit and tendencies of his writings, would hesitate to admit that he was a good and a great man—that he was a sincere friend to the poor,—and that his great aim in life was to promote the glory of God, and the wellbeing of his fellow-men—that he was a Scotchman of whom Scotland might be proud—and that his labours and his writings have gained a name, and established a reputation, which will not pass away.

The following Donations to the Library were announced :—

Catalogue of the Library of the Literary and Philosophical Society of Newcastle-upon-Tyne. 8vo.—*By the Society.*

Catalogue of the Library of the Royal College of Physicians of Edinburgh. 8vo.—*By the Royal College of Physicians.*

Journal of Agriculture, and Transactions of the Highland and Agricultural Society of Scotland. No. 24; (N. S.) 8vo.—*By the Society.*

Magnetische und Meteorologische Beobachtungen zu Prag. 1841, 1842, 1843, 1844, 1845, 1846, 1847, 1848. 4to.

Magnetische und Geographische Ortsbestimmungen Böhmen in dem Jahren 1843-5. Von Karl Kreil. 4to.

Magnetische und Geographische Ortsbestimmungen in Österreichischen Kaiserstaate. Erster Jahrgang. 1846. 4to.—*By the Observatory of Prague.*

Monday, March 19, 1849.

The Right Rev. Bishop TERROT, V. P., in the Chair.

The following Communications were read:—

1. An Attempt to compare the Exact and Popular Estimates of Probability. By Bishop Terrot.

The author began by defining probability as being that state of mind in which we are inclined to believe a proposition, without being absolutely convinced that it is true. Objectively, every proposition is either true or false; subjectively, it may be certainly true, probable, or impossible.

The measure of probability he shewed to be the same as the measure of the cause producing it; that is, the ratio of the reasons inclining us to believe a proposition, to the whole number of reasons bearing upon it, whether for or against; all of which reasons are founded, either upon necessary inference from experience, or from testimony.

How inference from experience may lead to a definite expectation of an event different from that which has been experienced, was shewn in the case of an urn, containing two balls, white or black, and from which a white has been drawn. There is then a probability of $\frac{1}{2}$ that the remaining ball will be black; and if a witness asserts that at a second drawing black was drawn, his credit must be very low indeed, if his assertion does not raise this probability from $\frac{1}{2}$ to above $\frac{1}{2}$, that is to say, render it more likely that the event in the second drawing was different from, though not contradictory, to that observed in the first drawing, than that it was not different.

The author then examined the probabilities arising from combined testimony, as expressed by the formula,

$$1 + \left(\frac{1-v}{v} \right)^n \cdot \frac{1-p}{p} = \pi$$

where p is the antecedent probability, v the average veracity of the witness, and n the number of witnesses. The cause of an antecedent probability was stated to be a natural tendency to believe in the continuity of series, and to be, in fact, a modification of the inference from experience.

It was then shewn, that this expression is applicable to the probable correctness of the verdicts of juries, assuming v to represent the probability of correctness in each jurymen. Taking the number of the jury at three, it appeared that the probability of getting a correct unanimous verdict, was to the probability of getting a correct verdict by a majority as 3 to 4. But, on the other hand, it appeared that assuming p to be $\frac{1}{10}$, the probability of error in the unanimous verdict is $\frac{1}{80}$, while the probability of error when two divide against one is $\frac{1}{8}$; that is to say, about eighty times as great as in the former case. Hence it was inferred that verdicts, by a bare majority, are admissible in civil cases, where it is sufficient that the verdict be probably correct; but not in criminal cases, where it is desirable that the probability of correctness should be carried as near to certainty as possible.

Lastly, Whereas there are, in every criminal charge, a certain number of points, all of which the jury desire to know, and which, if all proved, whether for or against the accused, would give a definite probability of his guilt or innocence, but of which one or more may remain untouched by the evidence, it was shewn that the jury would not deal fairly with the case if they threw the non-established point out of view, or if they gave the benefit of the doubt, as it is called, to the prisoner. Supposing $\frac{a}{a+b}$ to be the probability of guilt, independently of the non-established point, which must be considered as equally likely to be really for as against the accused, we must see that the consideration of this adds $\frac{1}{2}$ to a , and the same to b . So that $\frac{a}{a+b}$ becomes $\frac{a+\frac{1}{2}}{a+b+1}$; and these, reduced to a common denominator D , are $\frac{2a^2+2ab+2a}{D}$ and $\frac{2a^2+2ab+a+b}{D}$. So that the considera-

tion of the omitted point increases or diminishes the probability of guilt, according as $a + b$ is greater or less than $2a$, or a greater or less than b : That is to say, the preponderance of the greater probability is diminished by the consideration of each unproved note. If, as was supposed to be generally the case in criminal trials, the probability from the evidence preponderates against the accused, then he does get a benefit from the due consideration of each unproved note, though very far from the benefit he would have gained by proving it in his favour.

2. On the Gradual Production of Luminous Impressions on the Eye, and other phenomena of Vision. By William Swan, F.R.S.E.

The object of this communication was to ascertain the relation between the apparent brightness of a light, and the time during which it acts on the eye. In order to examine the intensity of luminous impressions of short duration, the author made use of discs, having sectors of known angles cut out of their circumferences, which were made to revolve at known velocities between the eye and a luminous object. In this manner, the object is seen at each revolution of the disc for a short interval of time, of which the duration is easily ascertained. An instrument termed a *selaometer* (from *σελας*, *brightness*), to indicate its use as a measure of the intensity of luminous impressions, was devised for the purpose of comparing the brightness of the flashes caused by the revolution of the disc, with a light of known intensity. This instrument consists of two screens, placed so as to face each other, having each a circular aperture of the same diameter, to which is fitted a piece of obscured glass. A disc, having a sector of a known angle, revolves in front of one of these screens, so that the aperture in it is visible at each revolution of the disc throughout the sector. The apertures are illuminated by gas flames behind them, which admit of having their distances from the screens varied, so as to increase or diminish the illumination of the apertures. A rectangular prism of glass is placed half way between the apertures, with its faces inclined at angles of 45° to the line joining their centres; so that they are seen in apparent contact by reflexion from the faces of the prism, and their relative brightness

can thus be compared with great nicety. The light behind the revolving disc is kept at a constant distance from the screen during an experiment; and, before causing the disc to revolve, the apertures are made equally bright by varying the distance of the other light from its screen. When the disc is put in motion, the apparent brightness of the aperture behind it is instantly diminished; and the equality of the apparent brightness of the apertures in the screens is restored, by increasing the distance of the light from the other screen. The ratio of the brightness of the impression produced by the light during the revolution of the disc, to the brightness of its impression, when seen by uninterrupted vision, is that of the squares of the distances of the other light from the aperture in its screen.

The following are the principal results obtained by means of this apparatus:—

(1.) When the eye receives, from a light of constant intensity, a succession of flashes of equal duration, which succeed each other so rapidly as to produce a uniform impression, this impression will also have a constant intensity, provided the number of flashes in a given time varies inversely with the duration of each flash.

(2.) The brightness of the impression produced by flashes of light of a given intensity, which succeed each other so rapidly as to produce a uniform impression on the eye, is proportional to the number of flashes in a given time.

(3.) When light of a given intensity acts on the eye for a short space of time, the brightness of the luminous impression on the retina is exactly proportional to the time during which the light continues to act. This law has been proved to be true for impressions lasting from $\frac{1}{18432}$ to $\frac{1}{24}$ of a second. The intensity of the impression produced by light which acts on the eye for $\frac{1}{100}$ of a second, is almost exactly $\frac{1}{10}$ of the brightness of the light when seen by uninterrupted vision; and it is also ascertained that light requires about the tenth part of a second to produce its full effect on the eye.

(4.) It is found that lights of different intensity act on the eye with equal rapidity, so that even the light of the sun produces an impression with no greater rapidity than that of a common gas flame.

(5.) Rays of different refrangibility act on the eye with equal rapidity.

(6.) Since Professor Wheatstone's experiments have proved that

the light of the electric spark of high tension continues for less than the millionth part of a second, and it has been shewn that the brightness of the impression, produced by light on the eye, increases in the exact arithmetical proportion of the time during which it continues to act on the retina, it follows that the apparent brightness of the electric spark is only $\frac{1}{1000000}$ of what it would become if the duration of the spark could be prolonged to $\frac{1}{10}$ th of a second. From the great apparent brilliancy of the nearly instantaneous electric spark of high tension, when compared with the sensibly continuous light of Voltaic electricity, it is inferred that the brightness of electrical light increases with the tension of the electricity.

3. Note on the Refractive and Dispersive Powers of the Humours of the Eye, determined by Experiment. By John Adie, Esq.

The author's object in undertaking these experiments, was to discover if the achromatism of the eye could be accounted for by the differences in the dispersive ratios of the fluids forming that organ.

The indices for several of the fixed lines were determined in the aqueous humour; with the crystalline no satisfactory result could be obtained.

In subjecting the vitreous humour to experiment, only the strongest of the fixed lines could be seen, and that with great difficulty; one remarkable feature, however, was observed, viz., that on dividing the mass of humours two spectrums were formed, the one placed over the other, having a greater deviation, and, consequently, refractive power. Thus proving, that that humour is not of equal density throughout, as has heretofore been supposed.

The following Donations to the Library were announced:—

The London University Calendar for 1849. 8vo.—*By the University.*

The Ethnological Journal, No. 10. 8vo.—*By the Editor.*

Suite of the Collection of Hydrographic Charts, with Sailing Directions, &c.—*By the Lords Commissioners of the Admiralty.*

Monday, 2d April 1849.

General Sir T. MAKDOUGALL BRISBANE, Bart.,
President, in the Chair.

The following Communication was read :—

1. On Grooved and Striated Rocks in the Middle Region of
Scotland. By Charles Maclaren, Esq.

In this paper an account was given of grooved, striated, and abraded rocks in various parts of Scotland, from Glen Spean on the north, to the Pentland and Lammermoor Hills on the south. After indicating the direction in which the groovings pointed, it was shewn,—that the appearance of these grooved and striated rocks is irreconcilable with the hypothesis which ascribes the phenomena to a supposed great Atlantic wave or transient flood, of which one part swept across the low lands of Scotland, while another part was turned back by the mountains,—that in the district between the Clyde and the Spean, where the largest and best marked groovings were observed, there is satisfactory evidence to prove, that they were produced by bodies of vast depth occupying the valleys, moving from the mountain group as a common centre, toward the coast and the Lowlands in all directions, and exerting an immense force of pressure vertically and laterally,—that this quaquaversal motion, as well as the form, position, and size of the groovings, are conclusive against the idea that they were caused by currents of water loaded with stones and gravel, since no collected mass of water exists, or could exist, of the requisite magnitude and elevation, to send out streams in all directions capable of acting powerfully at the height of a thousand feet or more above the bottoms of the valleys,—that the effects mentioned, therefore, can only be accounted for by the agency of glaciers, as exemplified in the Swiss Alps, where glacier ice is found covering immense areas, filling the valleys, and grooving and abrading their sides to the height of one or two thousand feet,—finally, that the striæ, groovings, and abrasion seen in the great central valley of Scotland, and on the Pentland Hills, are probably due to icebergs or rafts of ice, to which also the transportation of many travelled boulders may be ascribed.

The following Donations to the Library were announced :—

- Annuaire Météorologique de la France pour 1849. Par MM. J. Haeghens, Ch. Martins, et A. Bérigny. 8vo.—*By the Authors.*
- Bulletin des Séances de la Société Vaudoise, No. 19. 8vo.—*By the Society.*
- Memorie della R. Accademia delle Scienze di Torino. Serie 2da. Tom. VII., VIII., IX. 4to.—*By the Academy.*
- Öfversigt af Kongl. Vetenskaps-Akademiens Förhandlingar. 1847, No. 10; 1848, Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9. 8vo.
- Kongl. Vetenskaps-Akademiens Handlingar för År 1846. 8vo.—med Plaucher. 4to.
- Arsberättelse om Zoologiens Framsteg under Åren 1833–44. Tredje Delen, af S. Lovén. 8vo.
- Arsberättelse om Zoologiens Framsteg under Åren 1845 och 1846, af C. H. Boheman. 8vo.
- Arsberättelse om Framstegen i Kemi och Mineralogi, af Jac. Berzelius. 8vo.—*By the R. Academy of Stockholm.*
- Œuvres de Laplace. Tom. V., VI., VII. 4to.—*By the French Government.*
- Aanteekeningen, &c. van het Provinciaal Utrechtsch Genootschap van Kunsten en Wetenschappen. 1847 & 1848. 8vo.
- Verslag, &c. van het Provinciaal Utrechtsch Genootschap van Kunsten en Wetenschappen. 1847 & 1848, 12°.—*By the Society.*
- Report on the Epidemic Cholera at Madras in 1824. By William Scot. 8vo.—*By the Author.*

Monday, April 16, 1849.

Dr CHRISTISON, V.P., in the Chair.

The following communications were read :—

1. On a Simple Form of Rain-Gauge. By the Rev. Dr Fleming.

The author began by stating, that during a calm, when the rain-drop was under the influence of the centripetal force only, the form

and position of the rain-gauge were unimportant. The case, however, was widely different when the drop was likewise influenced by wind, for then any object raised above the surface, such as a rain-gauge projecting three or four feet from the ground, occasioned deflections and eddies, whereby the regular fall of the rain into the collector was prevented. The Author then recommended, that in all cases the gauge should be placed on the ground, with its mouth on a level with a regularly trimmed grass plot, so as to prevent eddies and evaporation. The form which he considered unexceptionable (an example executed by Mr James Bryson, 66 Princes Street, being exhibited) was that of a copper cylinder, with a funnel-form partition placed about an inch and a half below the mouth, having an aperture for the index of a float, which rises as the rain passes into the receiving portion of the lower part of the cylinder, at the bottom of which is a stopcock for letting off, at times, the accumulated water. A second cylinder of copper, closed at bottom, is provided, to be inserted into the ground for the reception of the gauge, the latter having a shoulder or flange to prevent the entrance of earth. By this arrangement the collector and receiver are equal in area, so that errors of workmanship are avoided. The state of the gauge is known by simple inspection of the index of the float, and extreme facility of emptying and adjusting the instrument secured.

2. On a Method of Cooling the Atmosphere of Rooms in a Tropical Climate. By Professor C. Piazzzi Smyth.

After stating the case distinctly, and dwelling emphatically on its importance, as shewn by individual instances in private life, and by the statistics of the world at large, the author proceeded to describe the various methods adopted at present in India, and shewed their incapacity to meet the end proposed, as they merely agitated the air already in a room, or perniciously overloaded it with moisture.

To take the most difficult case that could occur, he chose that of a country where the mean temperature of day and night, and summer and winter, is never below 80° , and where there could, consequently, be no coolness in springs or rivers, or in the night air; where also the atmosphere being saturated with moisture, no cold could be produced by evaporation; and under such circumstances

proposed that a method should be found of lowering the temperature of the air in a room ; doing, in fact, there, the reverse of what is effected in a cold room by lighting a fire.

The principle of the plan which he brought forward was dependent on the property of air to increase in temperature on compression, and to diminish on expansion ; the air was to be compressed by a forcing pump into a close vessel, then cooled or rather deprived merely of its acquired heat of compression, and then being allowed to escape into the room desired to be cooled, would issue at a temperature as much below that of the atmosphere as it had risen above on compression.

That this was a *vera causa* there was no doubt ; the *sufficiency* and the *practicability* were the only matters of doubt. These the author attempted to solve, by shewing the quantity of increase of heat due to a certain amount of compression ; and by devising the most convenient form of the necessary apparatus, and concluded that a one-horse power should supply a room with 30 cubic feet of air per minute, cooled 20° below the surrounding atmosphere. The various sources of mechanical power likely to be met with in warm countries, were then described ; and particularly a new and simple, and at the same time, a remarkably compact and effective form of windmill ; as the wind is everywhere so cheap and abundant, and in the tropics so certain a species of moving power. Methods also of ventilating the cooled room, *i. e.*, of keeping it constantly supplied with cooled fresh air, and removing the vitiated, were explained, as well as a natural principle for meeting the residual difficulty that might be expected to arise in some cases, *viz.*, the too great moisture of the cooled air.

3. Notice of a Shooting-Star. By Professor C. Piazzi Smyth.

The object of this notice was merely to call attention to the importance of observing the phenomena of shooting-stars more carefully and rigidly, and of applying to them more correctly than has generally been the case hitherto, the measurement of time and of space, and to exemplify what may be done in this way by the calculation of a recent instance. This instance, the rare one of an *ascending* shooting-star, was furnished by Captain W. S. Jacob, Bombay Engineers ; and he having given the place where the body first appeared, that

where it disappeared, and the time, the author of the paper, who had great faith in his friend's exactitude, considered the opportunity favourable for trying what results would be given by the application of Sir J. Lubbock's theory.

Some dissatisfaction has been felt about theories of shooting-stars, inasmuch as no one of them will explain *all* the observed phenomena. But though this is undoubtedly a necessary characteristic of a true theory, still great allowances are necessary here where so many different classes of cosmical and atmospherical objects may be confounded even by practised observers; and where the greater number of observers are utterly unpractised, and their senses wholly uneducated for scientific observation. Allowing that some electrical and magnetical effects have been mistaken for shooting-stars, but excluding the baseless electrical, chemical, and lunar hypotheses, a great proportion are undoubtedly of a cosmical nature, and belong properly to astronomy; and these may be divided into two classes of small bodies. *1st*, Those which are circulating round the sun as a primary; and *2dly*, Those which are revolving round the earth as such. The first we may occasionally see when passing near them in their orbits, but are not likely to come within sight of the same again, unless, indeed, they approach so near the earth as to gravitate towards it instead of the sun, and so become satellites or shooting-stars of the second class.

Sir J. Lubbock's theory is, that the shooting-stars shine by reflected light, and are extinguished by entering the earth's shadow; and he has given formulæ on this supposition for computing the distance of the body from the spectator by noting the place in the sky where, and the time when, the extinction occurs.

These formulæ have been rendered more convenient for computation by Mr Archibald Smith, *Phil. Mag.*, March 1849; and, computed according to them, Captain Jacob's observation gives, for the distance of the body from the observer, 1721 miles; and that entry into the earth's shadow was the true cause of the disappearance, is borne out by the fact that the direction of motion was *towards* the axis of the earth's shadow. And, on account of the extremely small distance of the body, its change of place during flight would sufficiently account for its gradually appearing in the lower part of the sky when coming out of conjunction, increasing in brilliancy during its flight (reaching, at its maximum, the brightness of Venus), and

then slowly vanishing as it entered first the penumbra and then the umbra of the earth's shadow, in a slanting direction ; and lastly, the body can hardly fail of being a satellite, as its distance is so much less than that of a shooting-star, which M. Petit of Toulouse has pretty well identified as revolving about the earth in $3^h 20^m$, or at about 3000 miles from the surface.

4. A few unpublished particulars concerning the late Dr Black. By Dr George Wilson.

The object of this communication was to lay before the Society a few characteristic incidents concerning Dr Black, gathered from Mrs Elizabeth Wordsworth, who was a servant in his household during the five last years of his life.

The facts recorded do not admit of abridgment, but they completely confirmed the accounts contained in the published biographies of Black, concerning his valetudinarian and methodical habits, whilst they gave no countenance to the statement which had been credited in some quarters, that the great chemist was an avaricious or penurious man. Some interesting particulars were adduced illustrative of the amiability and gentleness which characterised Dr Black ; and the author concluded by noticing that an error had been committed as to the date of the philosopher's death, which was not the 26th of November 1799, as stated by Robison, but the 6th December of that year, a fact which Mr Muirhead first pointed out (*Watt's Correspondence*, p. xxii.), but which is confirmed by the newspapers of the period. (*Vide Edinburgh Mercury* of 14th December 1799.)

Dr Christison then exhibited some interesting Specimens of Alum-Slate, illustrative of the Manufacture of Alum, and described both the natural and artificial processes.

The following Donations to the Library were announced :—

Journal of the Asiatic Society of Bengal. Edited by the Secretaries.

Nos. 196 and 197. 8vo.—*By the Editors.*

Proceedings of the Royal Astronomical Society. Vol. IX., No. 5.

8vo.—*By the Society.*

Monday, April 30, 1849.

Bishop TERROT, V.P., in the Chair.

The following communications were read :—

1. On a New Voltaic Battery of Intense Power. By Dr Wright. Communicated by Dr George Wilson.

The author placed on the table a battery of four pairs, each consisting of a rod of coke $2\frac{1}{2}$ inches long by $1\frac{1}{2}$ in diameter, surrounded by a cylinder of amalgamated zinc, $2\frac{1}{2}$ inches high by $2\frac{1}{4}$ inches in diameter; the different pairs were firmly attached to the same bar of wood, and could be immersed in jars of stoneware at once. The arrangement was charged with a mixture of nitric acid one part, sulphuric acid four parts, water eight parts. The author stated that he considered the power of the battery, which was twice that of Grove's, was due to the heat generated on the surface of the zinc by the local action of the nitric acid.

2. On a New Species of Manna, from New South Wales. By Thomas Anderson, M.D.

About thirty years ago a species of manna, obtained from the *Eucalyptus Mannifera*, was brought from New South Wales, and was examined by Dr Thomas Thomson, and afterwards by Professor Johnston, both of whom ascertained it to contain a new species of sugar, different from the mannite which exists in ordinary manna. The author had, through the kindness of Mr Sheriff Cay, an opportunity of examining a very different species of manna, remarkable both from its chemical constitution, and from its possessing a definitely organised structure. This substance was discovered by Mr Robert Cay in 1844, in the interior of Australia Felix, to the north and north-west of Melbourne, where it occurs at certain seasons on the leaves of the Mallee plant, *Eucalyptus Dumosa*, and is known to the natives by the name of Lerp.

It consists of numerous small conical cups of the average diameter of a sixth of an inch, more or less distinctly striated, and covered

on the outside with hairs of considerable length. The cup resembles some of the smaller species of patella, and its mouth is perfectly smooth and round. Several of the cups are frequently attached to one another by the edges, and always so that their mouths form a plane, by which it would appear they have been attached to the leaves. The hairs, when examined under the microscope, were found to consist of uniform tubes, with a granular structure, and indistinct traces of transverse striæ; they are coloured uniformly blue by iodine. The cups are made up of a confused mass of closely-compacted cells resembling starch globules, and coloured blue by iodine.

The taste of *Lerp* is distinctly saccharine, but this is confined entirely to the hair, the cup having merely a mucilaginous taste. The chemical examination shewed it to consist of an uncrystallisable sugar similar in its character to that found in fruits, of starch, gum, inulin, and cellulose, the absolute identity of the latter two of which was determined by ultimate analysis. There were also found minute traces of resinous matter and nitrogen, and 1·13 per cent of ash. The following is the result of its quantitative analysis :—

Water,	.	.	.	.	15·04
Sugar with a little resinous matter,	.	.	.	.	49·06
Gum,	.	.	.	.	5·77
Starch,	.	.	.	.	4·29
Inulin,	.	.	.	.	13·80
Cellulosa,	.	.	.	.	12·04
					100·00
Ash, ...	.	.	.	.	1·13

The author, in concluding his paper, remarked that all the species of manna before observed consisted of soluble substances, and were considered to be produced by the puncture of an insect, which caused the exudation of their constituents in the fluid form, and that they gradually dried up upon the surface of the leaf, but that the existence in *Lerp* of the insoluble cellulose and starch, and the sparingly-soluble inulin, seemed scarcely compatible with such an explanation of its origin.

3. Account of a peculiar Structure found in the *Vagmarus Islandicus*. By Dr John Reid. Communicated by Professor Goodsir.

4. Notes to a Paper on the Motive Power of Heat. By Professor William Thomson.

(1.) *On the Values of μ derived from Observations on the Vapours of various Liquids.*

An important test of the truth of the axiom on which Carnot's Theory is founded, will be afforded by comparing the values of μ deduced from observations on various liquids. I am informed by Mons. Regnault, that, by the end of this year, data as complete as those which we at present possess for water, will be supplied for five or six different liquids, from certain investigations with which he is now occupied. Carnot gives values of μ for the temperatures of the boiling of sulphuric ether, alcohol, water, and essence of turpentine, derived from various observations upon those liquids. The comparison of these with the values of μ , deduced from Regnault's continuous series of observations on water, are exhibited in the following table:—

Names of the Liquids.	Boiling-points.	Carnot's deduced values of μ .	Values of μ deduced from Regnault's Experiments on Water.	Differences.
		Ft. lbs.	Ft. lbs.	
Sulphuric Ether,	35.5	4.48	4.51	.03
Alcohol, . .	78.8	3.96	4.03	.07
Water, . .	100	3.66	3.84	.18
Essence of Turpentine, . }	156.8	3.53	3.45	-.08

The coincidences of the results obtained by such very different experiments are very striking. The differences certainly lie within the limits of the errors of observation; for it happens that the difference of the two results deduced by the different experimenters, from water at the boiling-point, is greater than any of the other differences. It is very remarkable that the feature of the gradual

decrease of μ with the temperature should be so clearly brought out by observations performed on different liquids, at different temperatures.

(2.) *On the Heat developed by the Compression of Air.*

Carnot demonstrates the following proposition :—

Equal volumes of all elastic fluids, when compressed to equal smaller volumes, disengage equal quantities of heat.

This very remarkable proposition, given as a theorem by Carnot, was enunciated as a probable experimental law by Dulong ; and it therefore affords a very powerful confirmation of Carnot's fundamental principle.

Mr Joule of Manchester has made some important experiments on this subject. The view which he takes of a thermal "equivalent" for motive power is at variance with Carnot's theory, but his experimental results agree with its indications in a very satisfactory manner. In endeavouring to effect a comparison, I found that the following propositions are a consequence of Carnot's Theory.

1. *In compressing a gas of which the temperature is kept invariable, the amount of work spent is exactly proportional to the quantity of heat developed.*

2. *The amount of work necessary to produce a unit of heat in this manner is the same, whatever be the gas operated on, but depends upon the temperature, being determined by the expression*

$$\frac{\mu (1 + E t)}{E}.$$

(3.) *On the Specific Heats of Gases.*

Carnot proves, as a theorem, that *the excess of the specific heat* under a constant pressure above the specific heat at a constant volume is the same for all gases at the same temperature and pressure.*

This result agrees well with the experimental results obtained by Dulong.

Carnot's theory affords the following determinate expression for the difference alluded to in the enunciation :

$$\frac{E^2 p}{\mu (1 + E t)^2}$$

* i. e. The "capacity for heat" of a unit of volume.

(4.) *Comparison of the Relative Advantages of the Steam-Engine and Air-Engine.*

In the steam-engine, with the expansive principle pushed to the utmost, as Carnot points out, the *effective range of temperature*, or the *fall* utilised, is from the temperature of the boiler to that of the condenser. The superior limit of temperature is restricted by the circumstance, that the pressure of saturated steam is enormously great for high temperatures; so that in practice, the temperature in the boiler is not in any ordinary engines so high as 150° per cent., but is in general very much below this limit. Carnot points out, that in this respect, the air-engine has a vast advantage over the steam-engine; as there is no limit to the temperature in the hot part, except such as the preservation of the materials requires; and, therefore, in it an enormously greater portion of the whole fall, from the temperature of the coals to that of the atmosphere, may be made use of. In other respects, we have no reason *a priori* for giving a preference to one kind of engine above the other. We cannot, however, feel confident that any air-engine has yet been constructed, which is capable of economising the fall actually used, as well as is done by steam-engines, with their comparatively limited range of temperature, or even that the duty for fuel consumed has in any actual air-engine exceeded or even come up to the duty performed by the best steam-engines.

(5.) *On the Economy of Actual Steam-Engines.*

The following table affords a synoptic view of the performances and theoretical duties, in various actual cases.*

When heat is transmitted from a body at 140° ,† through an engine, to a body at 30° , the work due to each unit of heat is 439 foot-pounds. This is the "theoretical duty" referred to in the last column in the table.

* I am indebted to the kindness of Professor Gordon, of Glasgow, for the experimental data.

† Pressure $3\frac{1}{2}$ atmospheres; 37 lb. on the square inch of the safety-valve.

TABLE A.—*Various Engines in which the Boiler is at 140°, and the Condenser at 30°.*

CASES.	Work produced for each lb. of coal consumed.	Work produced for each lb. of water evaporated.	Work produced for each unit of heat transmitted.	Per-centage of theoretical duty.
	Ft.-lbs.	Ft.-lbs.	Ft.-lbs.	
(1.) Fowey Consols Experiment, reported in 1845,	1,488,000	175,000	283	64½
(2.) Taylor's Engine at the United Mines, working in 1840,				
(3.) French Engines, according to contract,	* * * *	98,427	159	36
(4.) English Engines according to contract,	565,700	66,550	108	24½
(5.) Average actual performance of Cornish Engines,	631,000	74,240	120	27½
(6.) Common Engines, consuming 12 lb. of coal per hour, per horse-power.	165,000	19,410	31·4	7½
(7.) Improved Engines, with expansion cylinders; using an equivalent to 4 lb. of best coal per horse-power, per hour.	495,000	58,240	94·3	21½

5. Note regarding an Experiment suggested by Professor Robison. By Professor J. D. Forbes.

In his memoir of Dr Chalmers, lately read to this Society, Mr Ramsay has referred to an experiment which Dr Chalmers was anxious to have performed on the tide-wave in the Bay of Fundy. The object was to determine the earth's density by the attraction of the tide-wave on a plummet or spirit-level, on the same principle as

Maskelyne's experiment on Schiehallion, but with the superior advantages arising from the perfect homogeneity of the attracting mass, and from the circumstance that all the observations might be made at a single station. The experiment might, in short, appear to unite the advantages both of Maskelyne's and Cavendish's methods of determining the earth's density.

The suggestion was Dr Robison's, and Dr Chalmers had it from him. It is contained in the *Elements of Mechanical Philosophy*, Edit. 1804, page 339, and is given in the following words:—"Perhaps a very sensible effect might be observed at Annapolis-Royal in Nova Scotia, from the vast addition of matter brought on the coast twice every day by the tides. The water rises there above 100 feet at spring tide. If a leaden pipe a few hundred feet long were laid on the level beach, at right angles with the coast, and a glass pipe set upright at each end, and the whole filled with water, the water will rise at the outer end, and sink at the end next the land as the tide rises. Such an alternate change of level would give the most satisfactory evidence. Perhaps the effect might be sensible on a very long plummet, or even a nice spirit-level."

It is needless to observe that the methods proposed by Dr Robison are not the best which might be suggested; but that, in consequence of the extreme simplicity of the observation, considered as a purely astronomical one, a deviation of the direction of gravity of only a very few seconds could be ascertained within small limits of error.*

I thought it worth while to make the calculation approximately for an assumed height of the tide-wave. Had the result been at all encouraging I should have taken pains to ascertain, on good authority, the exact rise of the tide, and the circumstances of the locality whence the rise is greatest.

I have calculated the horizontal attraction of a semicylinder of water 100 feet thick, and of about two, four, and eight miles radius upon a point at the extremity of the axis of such a semicylinder; because these conditions can easily be reduced to calculation, and because

* The micrometric observation of a plumb-line, as in a zenith sector, would be sufficient; or, as Professor Smyth has suggested to me, the view of the wires of a transit instrument, with a collimating eye-piece, as reflected in a mercury trough,—an observation, the accuracy of which may, he states, be brought within $\frac{1}{10}$ of a second.

they represent very approximately the circumstances of an attracted point placed at high water-mark on a vertical sea-wall facing a basin or estuary. The radius of the attracting mass of water being represented (more accurately) by 10,000, 20,000, and 40,000 feet, I find the influence of a tide-wave 100 feet thick upon a plumb-line to produce a deviation of only $0^{\circ}44$ (forty-four hundredths of a second), $0^{\circ}50$, and $0^{\circ}53$; the effect increasing extremely slowly with the radius, as might be expected. If the tide rose only fifty feet, the first effect would be reduced to $0^{\circ}246$.

Even the greatest of these calculated deviations affords no ground for hoping that the method of Robison could be applied with any success to determine the earth's density.

It is rather singular that this ingenious suggestion is not once alluded to, so far as I am aware, by any writer on the figure and density of the earth; yet surely it was as worthy of notice as Dr Hutton's proposal to measure the attraction of an Egyptian pyramid.—(*Phil. Trans.* 1821.)

The following Donations to the Library were announced:—

American Journal of Science and Arts. Conducted by Professors Silliman and Dana. 2^d Ser. Vol. VII., No. 20. 8vo.—

By the Editors.

Ethnological Journal. No. 11. 8vo.—*By the Editor.*

Passages in the History of Geology. By Andrew C. Ramsay, F.G.S. 8vo. (2 copies.)—*By the Author.*

On the Nature of Limbs. By Richard Owen, F.R.S. 8vo.—*By the Author.*

Proceedings of the Philosophical Society of Glasgow. Vol. II. 1844–8. 8vo.—*By the Society.*

The Philosophy of Trade; or Outlines of a Theory of Profits and Prices. By Patrick James Stirling. 8vo.—*By the Author.*

